mathematically moving the positions of the probes as determined by the positioning means relative to a predefined set of integrated circuit pad location data. In this manner, the best fit between the measured probe positions and the locations of the pads is achieved in order to minimize the number of probe positions which need to be adjusted. Thus, it is not necessary to visually align the probes on a probe card with the integrated circuit. Nor, for that matter, is it even necessary to have the integrated circuit available when inspecting the probe card. This presents significant advantages over the prior art for reasons discussed more fully below. Support for the amendment to claim 1 is found, for example, in the paragraph bridging pages 15-16 in the specification.

I. Formal Rejections

The Examiner rejects claims 1-5 under 35 U.S.C. §112, second paragraph, as being indefinite. Specifically, the Examiner states that "claim 1, lines 7-8 recite the position of the probes, but the actual recitation of determining the position is not recited until later in the claim (lines 9-12)." In response, claim 1 has been carefully reviewed and amended in order to eliminate any ambiguity or indefiniteness that may be perceived. In particular, claim 1 has been amended to clarify that the computer means includes the positioning means and means for mathematically moving as described more fully below.

In view of the above noted amendment to claim 1, it is believed that claims 1 and 2-5 which depend therefrom now fully and concisely define that which applicants regard as their invention. Accordingly, withdrawal of the rejection under 35 U.S.C. §112, second paragraph, is respectfully requested.

II. Rejection of Claims 1, 2, 4 and 9 Under 35 U.S.C. §103

Claims 1, 2, 4 and 9 stand rejected under 35 U.S.C. §103 as being unpatentable over Sato et al. in view of Stewart et al.

The present system, as recited in claim 1, affords for automatic inspection of all critical parameters of integrated circuit probe cards. The system includes a viewing system for providing a digital image of the tip of each probe and a window

with a flat surface contacted by each of the probe tips such that the viewing system obtains the digital image of each probe tip through the window. The system further includes a computer means with software means to determine and analyze the position of each probe within the digital image, and positioning means to determine the position of each probe tip in the digital image relative to a known physical position in order to determine the location of the probes relative to each other. Moreover, the computer means includes means for mathematically moving the positions of the probes as determined by the positioning means relative to a predefined set of pad location data representative of locations of integrated circuit pads which are to be contacted by the probes and obtaining a best fit therebetween, and identifying a minimum number of the probes which need to be adjusted with respect to position in order that all of the probes will be aligned with the respective integrated circuit pads.

Sato et al. describes a wafer prober which determines the positions of select probe needles on a probe card and pads on a wafer in order to align the probe card with the wafer to which the probe card is applied. More specifically, the positions of one or more probes is measured via a TV camera. The measured positions are used as a map by a second camera to verify the presence of a bonding pad on the wafer itself. Angular error between the probe tips and bonding pads is adjusted by moving the entire probe card with respect to the wafer or the wafer with respect to the entire probe card to align the array of probes to the pads.

Notably, the wafer prober in Sato et al. is not concerned with the inspection of the probe card itself, and particularly with the inspection of the relative positioning of the probes. Sato et al. is not concerned with inspection of the probe card to determine specifically which probes may require adjustment and how such adjustment can be carried out by adjusting a minimum number of probes. Sato et al. clearly is not concerned with such testing of the probe card because the wafer prober in Sato et al. is using the probe card, not testing the probe card.

Claim 1, as amended, defines an inspection system for probes in a probe array. A computer means determines the position of each probe via a digital image

obtained by a viewing system through a window. Unlike Sato et al., the computer means analyzes the relative position of each of the probes by mathematically moving the positions of the probes relative to a predefined set of pad location data. For example, by mathematically translating and rotating the positions of the probes as determined from the digital image, a best fit between the locations of the probes and the location of the pads is obtained. Based on such best fit, a minimum number of probes which need to be adjusted with respect to position in order to achieve alignment is identified.

Hence, claim 1 defines a system for identifying specifically which particular probes need to be adjusted in order to bring a probe card within specification. Such information is obtainable even without the integrated circuit itself. By use of the computerized best fit analysis, the present invention avoids the problems associated with systems that are based on a fixed reference. As is discussed in the present specification, the system avoids problems associated with those instances where the probe card itself may be improperly positioned so as to provide a false reference. (Spec., p. 16, lns. 1-4). Also, it reduces the number of adjustments to the individual probes which need to be conducted. (Spec., p. 16, lns. 4-11).

Sato et al. does not teach or suggest an integrated circuit probe card inspection system as recited in claim 1. Sato et al. does not teach or suggest any type of mathematical movement of the positions of the probes relative to a predefined set of pad location data to obtain a best fit in order to identify the minimum number of probes which need to be adjusted.

The Stewart et al. reference does not make up for the deficiencies in Sato et al. Stewart et al. does not teach or suggest the claimed means for mathematically moving the positions to obtain a best fit in order to identify the minimum number of probes which need to be adjusted. Stewart et al. discusses correcting for angular error such that the entire probe card can be moved relative to the bonding pads, but Stewart et al. does not address the correction of the position of individual probes. (Col. 14, lns. 25-57). Like Sato et al., Stewart et al. discusses such angular correction in association with aligning the probe card with the integrated circuit

itself. The system described in Stewart et al. in such instances is not concerned with the inspection of the probe card to determine individual probe locations which need to be adjusted, but rather is concerned with obtaining an optimum alignment with the integrated circuit by simply moving the entire probe card relative to the integrated circuit.

Accordingly, claim 1 can be patentably distinguished over the teachings of Sato et al. and Stewart et al. whether taken alone or in combination.

Regarding claim 9, the invention relates to a method for learning the probe tip locations for a plurality of probe tips in an existing known good probe card. In particular, a digitized image of each probe tip on the probe card is captured and the relative position of each probe tip is then determined with respect to the other probe tips on the probe card. A file of the relative position information is constructed for use in determining the correct placement of probe tips on other probe cards of a same type. Sato et al. teaches only the feature of identifying the location of probe tips using a video camera but does not teach or suggest a method for accumulating a file of relative position information for use in identifying the correct placement of probe tips on other probe cards.

Stewart et al. relates to a system for inspecting a probe card, but does not teach or suggest the concept of digitizing and determining the relative positions of probe tips in a known good probe card as claimed. Specifically, Stewart et al. does not teach or suggest constructing a file of the learned relative position information for use in determining the correct placement of probe tips on other probe cards of the same type. Again, therefore, Stewart et al. does not make up for the deficiencies in Sato et al.

Accordingly, the rejection under 35 U.S.C. §103 of claim 1 and claims 2 and 4 which depend therefrom along with independent claim 9 should be withdrawn.

II. Rejection of Claims 3, 5, 8 and 10 Under 35 U.S.C. §103

Claims 3, 5, 8 and 10 are rejected under 35 U.S.C. §103 as being unpatentable over Sato et al. in view of Stewart et al. (presumably, although it is

unclear from the Office Action) and further in view of Chang et al. This rejection is respectfully traversed for at least the following reasons.

Claims 3 and 5 depend from claim 1. Chang et al. does not make up for the deficiencies of Sato et al. and Stewart et al. advanced above in regards to the patentability of claim 1. Accordingly, the rejection of claims 3 and 5 under 35 U.S.C. §103 should be withdrawn.

In regards to claim 8, neither Sato et al., Stewart et al. or Chang et al. whether viewed alone or in combination teach or suggest measuring the length of a probe tip extending from a probe shank as claimed. Claim 8 defines an apparatus in which a contacting means sequentially contacts a distal end of the probe tip and the shank from which the probe tip extends. A measuring means measures the vertical height of each contacted point and a calculating means determines the difference in the two measured heights in order to determine the length of the probe tip. This aspect of the invention is best exemplified in Figs. 7a and 7b.

The Examiner has failed to indicate where in any of the applied references there is any teaching or suggestion measuring of the length of the probe tip as recited in claim 8. Absent any such teaching or suggestion, the rejection is clearly improper.

Likewise, neither Sato et al., Stewart et al. or Chang et al. viewed alone or in combination teach or suggest the specific method recited in claim 10 for determining the orientation and spatial position of an array of probes. There is no teaching or suggestion of moving the field of view of a video microscope in a predetermined direction not exceeding the X or Y dimension of the array, and then, if no probes are found, moving along the opposite direction and along the positive and negative directions of the other axis until probes are found in the field of view.

Accordingly, withdrawal of the rejection under 35 U.S.C. §103 of claims 3, 5, 8 and 10 is respectfully requested.

III. Conclusion

For at least the above reasons, claims 1-5 and 8-10 are believed to be allowable and the application in condition for allowance. A prompt action to such end is earnestly solicited.

Should the Examiner believe that a telephone interview would be helpful to expedite favorable prosecution, the Examiner is invited to contact Applicant's undersigned representative at the telephone number listed below.

In the event any fees are due in connection with the filing of this document, the Commissioner is authorized to charge those fees to Deposit Account No. 18-0988.

Respectfully submitted,

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CERTIFICATE OF MAILING

I hereby certify that this correspondence (along with any paper referred to as being attached or enclosed) is being deposited with the United States Postal Service on the date shown below with sufficient postage as first class mail in an envelope addressed to: Assistant Commissioner for Patents, Washington, D.C. 20231

Date: April 2, 1996

Mark D. Saralino